WE CLAIM:

1. A virus-like particle for use as an immunogen, comprising a first hepatitis B virus surface antigen (HBsAg) and a chimeric antigen, wherein the chimeric antigen comprises a second HBsAg which is covalently linked to an HCV immunogenic polypeptide, and wherein the first and the second HBsAg each comprise a substantially complete S domain.

2. The virus-like particle of claim 1, wherein the first HBsAg consists essentially of preS2 and S domains.

3. The virus-like particle of claim 2, wherein the first HBsAg consists essentially of preS1, preS2, and S domains.

4. The virus-like particle of claim 1, wherein the carboxy terminus of the HCV immunogenic polypeptide is linked to the amino terminus of the second HBsAg.

5. The virus-like particle of claim 1, wherein the first HBsAg is expressed in excess relative to the chimeric antigen.

6. The virus-like particle of claim 5, wherein the first HBsAg is expressed using an amount of DNA that is between 1 and 100 times the amount of DNA used to express the chimeric antigen.

7. The virus-like particle of claim 1, wherein the HCV immunogenic polypeptide comprises an HCV E1 glycoprotein, a fragment of an HCV E1 glycoprotein, an HCV E2 glycoprotein, or a fragment of an HCV E2 glycoprotein.

8. The virus-like particle of claim 1, wherein the HCV immunogenic polypeptide consists essentially of an HCV E1 glycoprotein, a fragment of an HCV E1 glycoprotein, an HCV E2 glycoprotein, or a fragment of an HCV E2 glycoprotein.

9. The virus-like particle of claim 7, wherein the HCV immunogenic polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

10. The virus-like particle of claim 7, wherein the HCV immunogenic polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

11. The virus-like particle of claim 10, wherein the HCV immunogenic polypeptide consists essentially of amino acid residues 384 to 661 of an HCV polyprotein.

12. The virus-like particle of claim 1, wherein the HCV immunogenic polypeptide comprises (1) an HCV E1 glycoprotein or a fragment thereof and (2) an HCV E2 glycoprotein or a fragment thereof.

13. A virus-like particle for use as an immunogen, comprising a first HBsAg and first and second chimeric antigens, wherein the first chimeric antigen comprises a second HBsAg which is covalently linked to a first immunogenic polypeptide comprising an HCV E1 glycoprotein or a fragment thereof, wherein the second chimeric antigen comprises a third HBsAg which is covalently linked to a second immunogenic polypeptide comprising an HCV E2 glycoprotein or a fragment thereof, and wherein the first, second, and third HBsAg each comprise a substantially complete S domain.

14. The virus-like particle of claim 13, wherein the first HBsAg consists essentially of preS2 and S domains.

15. The virus-like particle of claim 13, wherein the first HBsAg consists essentially of preS1, preS2, and S domains.

16. The virus-like particle of claim 13, wherein the carboxy terminus of the first immunogenic polypeptide is linked to the amino terminus of the second HBsAg and the carboxy terminus of the second immunogenic polypeptide is linked to the amino terminus of the third HBsAg.

17. The virus-like particle of claim 13, wherein the first HBsAg is expressed in excess relative to the total amount of the first and second chimeric antigens.

18. The virus-like particle of claim 17, wherein the first HBsAg is expressed using an amount of DNA that is between 1 and 100 times the total amount of the DNA used to express the first and second chimeric antigens.

19. The virus-like particle of claim 13, wherein the first immunogenic polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

20. The virus-like particle of claim 13, wherein the second immunogenic polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

21. The virus-like particle of claim 13, wherein the first immunogenic polypeptide consists essentially of amino acid residues 192 to 330 of an HCV-1

polyprotein and the second immunogenic polypeptide consists essentially of amino acid residues 384 to 661 of an HCV-1 polyprotein.

22. A fusion protein comprising:

a substantially complete S domain of HBsAg; and

a polypeptide comprising (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

23. The fusion protein of claim 22, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

24. The fusion protein of claim 22, wherein the polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

25. The fusion protein of claim 22 comprising the amino acid sequence displayed in SEQ ID NO:5, or an immunogenic sequence having at least about 80% sequence identity thereto.

26. A fusion protein comprising:

a substantially complete S domain of HBsAg; and

a polypeptide comprising (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

27. The fusion protein of claim 26, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

28. The fusion protein of claim 26, wherein the polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

29. The fusion protein of claim 26 comprising the amino acid sequence displayed in SEQ ID NO:7, or an immunogenic sequence having at least about 80% sequence identity thereto.

30. A nucleic acid molecule which encodes a fusion protein comprising:
a substantially complete S domain of HBsAg; and
a polypeptide comprising (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

31. The nucleic acid molecule of claim 30, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

32. The nucleic acid molecule of claim 30, wherein the polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

33. The nucleic acid molecule of claim 30 comprising nucleotides 1992 through 3584 of SEQ ID NO:4, or an immunogenic sequence having at least about 80% sequence identity thereto.

34. A nucleic acid molecule which encodes a fusion protein comprising:
a substantially complete S domain of HBsAg; and
a polypeptide comprising (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

35. The nucleic acid molecule of claim 34, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

36. The nucleic acid molecule of claim 34, wherein the polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

37. The nucleic acid molecule of claim 34 comprising nucleotides 1992 through 3584 of SEQ ID NO:6, or an immunogenic sequence having at least about 80% sequence identity thereto.

38. A vector comprising a nucleic acid molecule which encodes a fusion protein comprising:

a substantially complete S domain of HBsAg; and

a polypeptide comprising (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

39. The vector of claim 38, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

40. The vector of claim 38, wherein the polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

41. The vector of claim 38 whose nucleotide sequence is displayed in SEQ ID NO:4, or an immunogenic sequence having at least about 80% sequence identity thereto.

42. A vector comprising a nucleic acid molecule which encodes a fusion protein comprising:

a substantially complete S domain of HBsAg; and

a polypeptide comprising (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

43. The vector of claim 42, wherein the substantially complete S domain is covalently attached at its amino terminus to the polypeptide.

44. The vector of claim 42, wherein the polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

45. The vector of claim 42 whose nucleotide sequence is displayed in SEQ ID NO:6, or an immunogenic sequence having at least about 80% sequence identity thereto.

46. An immunogenic composition comprising:

a virus-like particle comprising a first HBsAg and a chimeric antigen, wherein the chimeric antigen comprises a second HBsAg which is linked to an HCV immunogenic polypeptide, and wherein the first and the second HBsAg each comprise a substantially complete S domain; and

a pharmaceutically acceptable carrier.

47. The immunogenic composition of claim 46, wherein the first HBsAg is expressed in excess compared to the chimeric antigen.

48. The immunogenic composition of claim 47, wherein the first HBsAg is expressed using an amount of DNA that is between 1 and 100 times the amount of DNA used to express the chimeric antigen.

49. The immunogenic composition of claim 46, wherein the HCV immunogenic polypeptide comprises an HCV E1 glycoprotein, a fragment of an HCV E1 glycoprotein, an HCV E2 glycoprotein, or a fragment of an HCV E2 glycoprotein.

50. The immunogenic composition of claim 46, wherein the HCV immunogenic polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

51. The immunogenic composition of claim 46, wherein the HCV immunogenic polypeptide consists essentially of amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

52. The immunogenic composition of claim 46, wherein the HCV immunogenic polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

53. The immunogenic composition of claim 46, wherein the HCV immunogenic polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

54. An immunogenic composition comprising virus-like particles, comprising a first HBsAg and first and second chimeric antigens, wherein the first chimeric antigen comprises a second HBsAg which is linked to a first immunogenic polypeptide comprising an HCV E1 glycoprotein or a fragment thereof, wherein the second chimeric antigen comprises a third HBsAg which is linked to a second immunogenic polypeptide comprising an HCV E2 glycoprotein or a fragment thereof, and wherein the first, second, and third HBsAg each comprise a substantially complete S domain.

55. The immunogenic composition of claim 54, wherein the first HBsAg consists essentially of preS2 and S domains.

56. The immunogenic composition of claim 54, wherein the first HBsAg consists essentially of preS1, preS2, and S domains.

57. The immunogenic composition of claim 54, wherein the carboxy terminus of the first immunogenic polypeptide is linked to the amino terminus of the second HBsAg and the carboxy terminus of the second immunogenic polypeptide is linked to the amino terminus of the third HBsAg.

58. The immunogenic composition of claim 54, wherein the first HBsAg is expressed in excess relative to the total amount of the first and second chimeric antigens.

59. The immunogenic composition of claim 58, wherein the first HBsAg is expressed using an amount of DNA that is between 1 and 100 times the amount of DNA used to express the chimeric antigen.

60. The immunogenic composition of claim 54, wherein the first immunogenic polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

61. The immunogenic composition of claim 54, wherein the second immunogenic polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

62. An immunogenic composition comprising a nucleic acid molecule which encodes a fusion protein comprising a substantially complete S domain of HBsAg

covalently linked to a polypeptide comprising (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b).

63. The immunogenic composition of claim 62, wherein the substantially complete S domain is covalently linked at its amino terminus to the polypeptide.

64. The immunogenic composition of claim 62, wherein the polypeptide comprises (a) amino acid residues 192 to 330 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

65. The immunogenic composition of claim 62 comprising the nucleotide sequence displayed in SEQ ID NO:4, or an immunogenic sequence having at least about 80% sequence identity thereto.

66. An immunogenic composition comprising a nucleic acid molecule which encodes a fusion protein comprising a substantially complete S domain of HBsAg covalently linked to a polypeptide comprising (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates; or (c) an immunogenic sequence having at least about 80% sequence identity to (a) or (b)

67. The immunogenic composition of claim 66, wherein substantially complete S domain is covalently linked at its amino terminus to the polypeptide.

68. The immunogenic composition of claim 66, wherein the polypeptide comprises (a) amino acid residues 384 to 661 of an HCV-1 polyprotein; or (b) the corresponding residues of other HCV isolates.

69. The immunogenic composition of claim 66 comprising the nucleotide sequence displayed in SEQ ID NO:6, or an immunogenic sequence having at least about 80% sequence identity thereto.

70. A method of producing virus-like particles comprising the steps of:

culturing a cell in a culture medium, whereby the cell expresses virus-like particles comprising a first HBsAg and a chimeric antigen, wherein the chimeric antigen comprises a second HBsAg which is covalently linked to an HCV immunogenic polypeptide, and wherein the first and the second HBsAg each comprise a substantially complete S domain; and

isolating the virus-like particles from the culture medium.

71. The method of claim 70, wherein the cell is a CHO cell or a COS cell.

72. A method of producing a cell line that expresses virus-like particles, comprising the steps of:

transfecting a cell with a vector that expresses virus-like particles comprising a first HBsAg and a chimeric antigen, wherein the chimeric antigen comprises a second HBsAg which is covalently linked to an HCV immunogenic polypeptide, and wherein the first and the second HBsAg each comprise a substantially complete S domain; and

culturing the cell to produce a cell line that expresses the virus-like particles.

73. The method of claim 72, wherein the vector is a plasmid vector.

74. The method of claim 72, wherein the plasmid vector is pCMVII opti 330 E1 (SEQ ID NO:4) or pCMV-II-E2661-sAg (SEQ ID NO:6).

75. The method of claim 72, wherein the vector is a viral vector.

76. The method of claim 75, wherein the viral vector is essentially free of infectious virus.

77. A cell line that expresses a virus-like particle comprising a first HBsAg and a chimeric antigen, wherein the chimeric antigen comprises a second HBsAg which is linked to an HCV immunogenic polypeptide, and wherein the first and the second HBsAg each comprise a substantially complete S domain.

78. A cell line that expresses a virus-like particle comprising a first HBsAg and first and second chimeric antigens, wherein the first chimeric antigen comprises a second HBsAg which is linked to a first immunogenic polypeptide comprising an HCV E1 glycoprotein or a fragment thereof, wherein the second chimeric antigen comprises a third HBsAg which is linked to a second immunogenic polypeptide comprising an HCV E2 glycoprotein or a fragment thereof, and wherein the first, second, and third HBsAg each comprise a substantially complete S domain.